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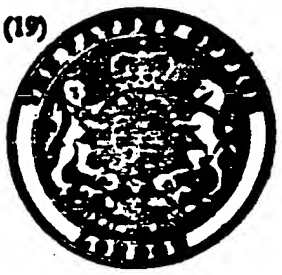



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## (54) IMPROVEMENTS IN AND RELATING TO DOSEMETERS


(71) We, COMMISSARIAT A L'ENERGIE ATOMIQUE, an organisation created in France by ordinance No. 45-2563 of 18th October 1945, of 29 Rue de la Federation, Paris 15e, France, do hereby declare the invention for which we pray that a patent may be granted to us and the method by which it is to be performed to be particularly described in and by the following statement:—


This invention relates to dosemeters.

The fact that ionising radiations form long-life free-radicals in different substances provides a means of measuring the dose of such radiation absorbed in the substance concerned (J. COMBRISSON and J. UEBERSFELD, Comptes-Rendus, Académie des Sciences, pages 1397 and 1398 (1954).

In particular, the fact that it is possible to observe such radicals in organic substances whose chemical composition is similar to that of the tissues, should provide a direct measurement of the radiation dose absorbed by the tissues.

However, the rate of formation of the observable free-radicals in dependence on the absorbed dose depends on various factors. In particular, it varies according to the nature and quality of the radiation. It may also depend on exposure or measurement conditions (temperature, humidity, the presence or absence of oxygen, and so on).

Various substances, more particularly amino acids and polymers, have been used for free-radical dosimetry.

This utilisation is effected by comparison of the number of radicals created in the unit of mass of the substance under consideration by an unknown dose of a given radiation and the experimental standardisation curve plotted with known doses of the same radiation. This curve is valid only for a radiation of given nature and energy.

The radiological dosemeter according to the invention consists of a mixture of a substance which generates free-radicals, and one or more other substances which improve the yield of free-radicals for a given radiation dose.

Dosemeters according to the invention may contain 65 to 95% by weight of alanine 5 to 35% by weight of paraffin and, if required, a small quantity (between 1% and 10%) of an element of higher atomic number to reinforce the response to low-energy photons.

Paraffin may be replaced by other highly hydrogenated substances, such as polyethylene and polystyrene.

Alanine, which is used in the crystallised form, serves as a substance which generates free-radicals which are stable under the action of radiation.

Paraffin acts both as a binder and a coating to protect the alanine crystals from atmospheric humidity.

The paraffin increases the alanine response to neutrons by increasing the hydrogen content of the dosemeter.

It does not deliver sufficiently stable radicals at ordinary temperature to influence the dosemeter response.

Other hydrogenated substances, such as polyethylene and polystyrene, similarly improve the response to neutrons without providing radicals which are stable at ordinary temperature, and may be used instead of paraffin.

Preparation of the dosemeter according to the invention comprises hot-stirring of the constituents of the mixture, cooling of the mixture, and compaction thereof to form cylindrical pellets, for example by means of a hydraulic press.

The proportions of the various constituents of the mixture depend upon the required properties of the dosemeter. The hydrogenated substance content is increased if the response to high-energy neutrons is to be improved.

A dosemeter according to the invention is

characterised by a wide linearity range and by adjustable sensitivity for different types of radiation. It allows non-destructive reading.

Also, it has the following additional advantages over dosemeters which contain alanine alone;

Lower sensitivity to ambient conditions.

It is more equivalent to the tissues as regards the ratio of the measured signal to the dose absorbed in the tissues.

Improved sensitivity and reproducibility.

The measured signal/measured dose response can be adjusted in dependence on the radiation and on the material in which the dose is required to be known; in particular, the response to neutrons can be boosted for dosimetry of mixed gamma and neutron fluxes.

It can be used as an implant with perfect tolerance.

The dosemeters according to the invention can be used in the dosimetry of strong X or $\gamma$ irradiations: in the tissues, foodstuffs or radiation chemistry, and in the dosimetry of mixed irradiations ($\alpha$ and X or $\gamma$ and neutron): critically accidents, space dosimetry, accelerator beams.

Some exemplified embodiments of the invention will now be given without any limiting force.

### Example 1

A dosemeter was prepared consisting of 80% of alanine and 20% of paraffin.

Mixing was carried out by hot-stirring of the constituents at 80°C.

The mixture was cooled and compressed in the form of cylindrical pellets by means of a hydraulic press.

A dosemeter according to the invention provides accurate measurement of a known X, $\gamma$ or n radiation between 5 and $5.10^6$ rads. It provides evaluation to better than within 20% of the total dose of an unknown mixture of $\gamma$ and fission neutrons.

### Example 2

A dosemeter was prepared consisting of 80% of alanine and 20% of polyethylene. Mixing was carried out by hot-stirring of the constituents.

The mixture was cooled and compressed in the form of cylindrical pellets by means of a hydraulic press.

### Example 3

A dosemeter was made which contained a small quantity of calcium carbonate.

The proportions of the constituents of the mixture were determined to give a response equivalent to that of the tissues to X and $\gamma$ radiations between 10 KeV and 10 MeV. The dosemeter had the following composition: alanine 77%, paraffin 18% and calcium carbonate 5%.

### Example 4

3% of barium carbonate was incorporated in the dosemeter as described in example 1.

The dosemeter had a response equivalent to that of the tissues to X and gamma radiations between 30 KeV and 10 MeV.

## WHAT WE CLAIM IS:—

1. A free-radical radiological dosemeter, consisting of a mixture of a substance which generates free-radicals, and one or more other substances which improve the free-radical yield for a given radiation dose.

2. A dosemeter according to Claim 1, containing 65 to 95% by weight of alanine and 5 to 35% by weight of paraffin.

3. A dosemeter according to Claim 1, containing 65 to 95% by weight of alanine, and 5 to 35% by weight of polyethylene.

4. A dosemeter according to Claim 1, containing 65 to 95% by weight of alanine and 5 to 35% by weight of polystyrene.

5. A dosemeter according to any of Claims 1 to 4, containing 1% to 10% by weight of an element of a higher atomic number adapted to boost the response to low-energy photons.

6. A dosemeter according to Claim 5, wherein said element is calcium.

7. A dosemeter according to Claim 5, wherein said element is barium.

8. A dosemeter substantially as herein described in any of the Examples.

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